

Sand to Silicon

Josh Walden
Fab24 Plant Manager



thirty-five **35** years of innovation →

The journey from 1968 to today.....

intel

thirty-five **35** years of innovation →

The First Use of the Microprocessor



Busicom Calculator - 1971

Clean Room Evolution



1968



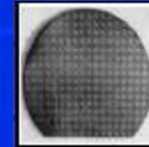
Today

intel

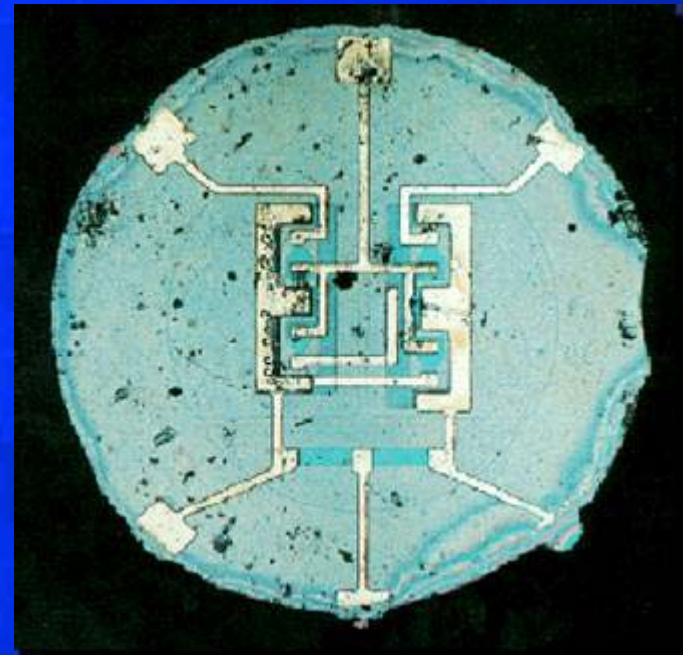
thirty-five **35** years of innovation →

Some History!

- 1" wafer of Planar Transistors, ~1959



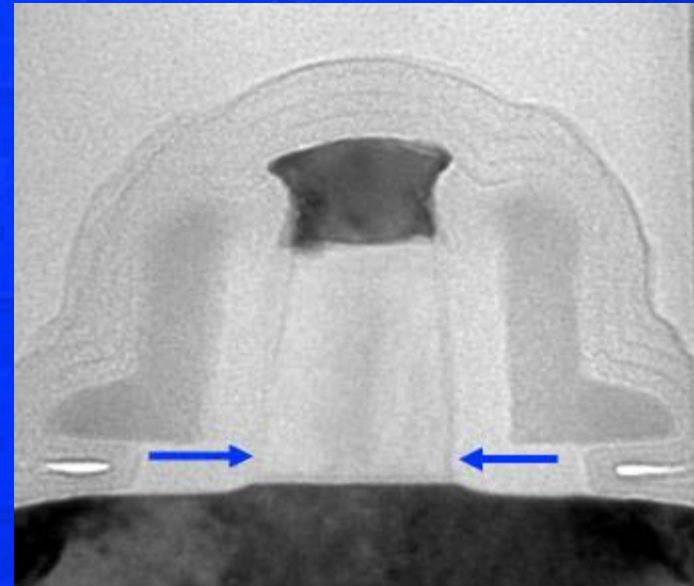
- The 1st Planar integrated circuit in 1961



Transistor Evolution



Old Transistor

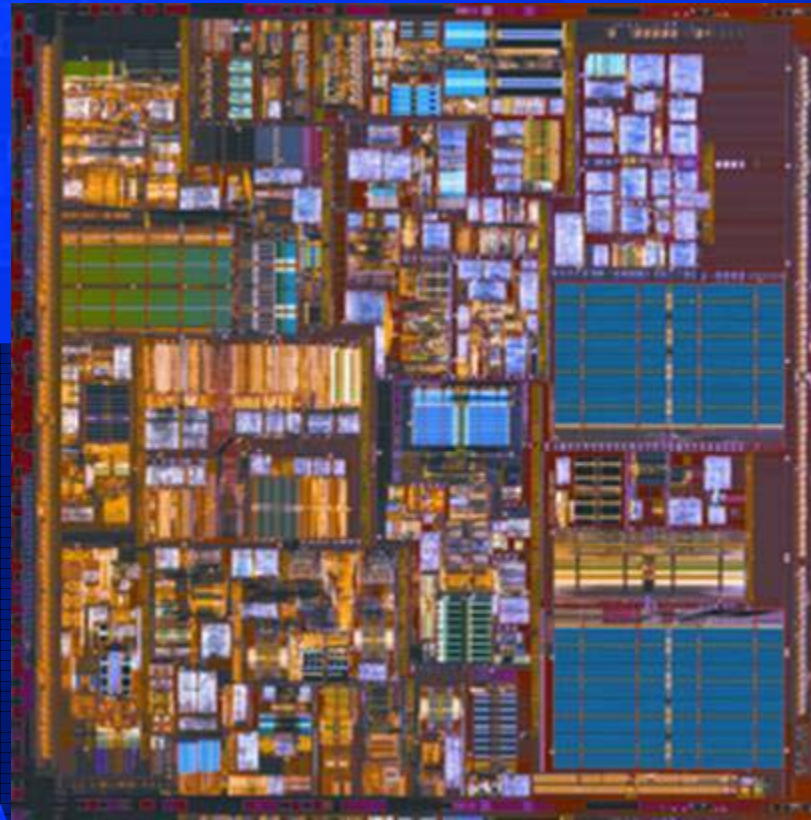


Today
50nm Transistor Gate

Die Evolution



1971
4004 Processor

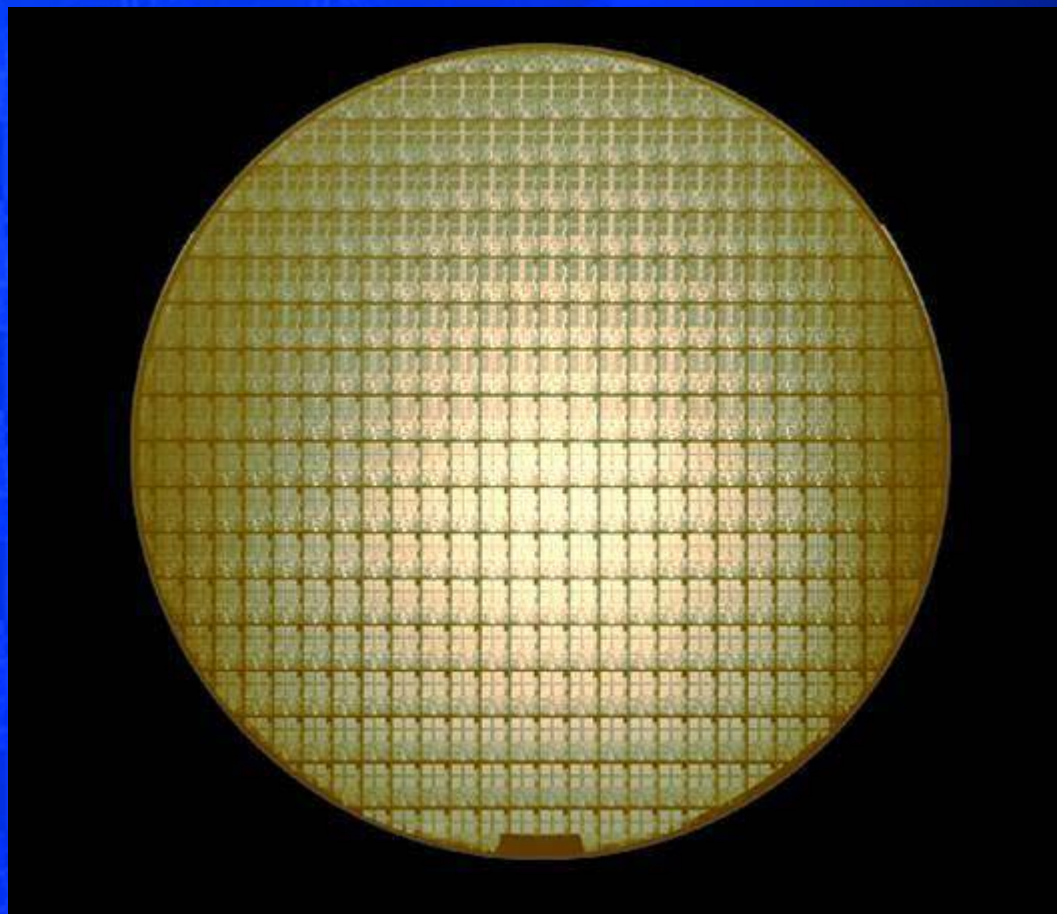


Today
Pentium®4 Processor Die

Wafer Evolution

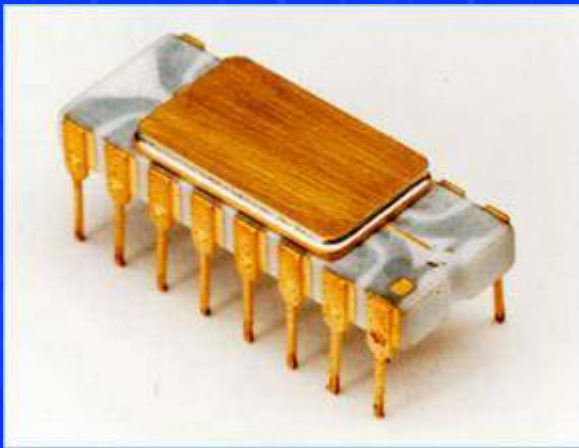


1971
2" Wafer



Today
12" Wafer

Microprocessor Packages



1971



Today



CLIENTS

**Intel
Silicon
Core of the
Internet**



NETWORKING



SERVERS

intel

... of innovation →

Sand to Silicon Chips

How do you get from this...



to this?



Silicon at the heart of Intel



Silicon Ingot



Silicon Wafer

Pentium® 4
processor die



Pentium® 4 Processor



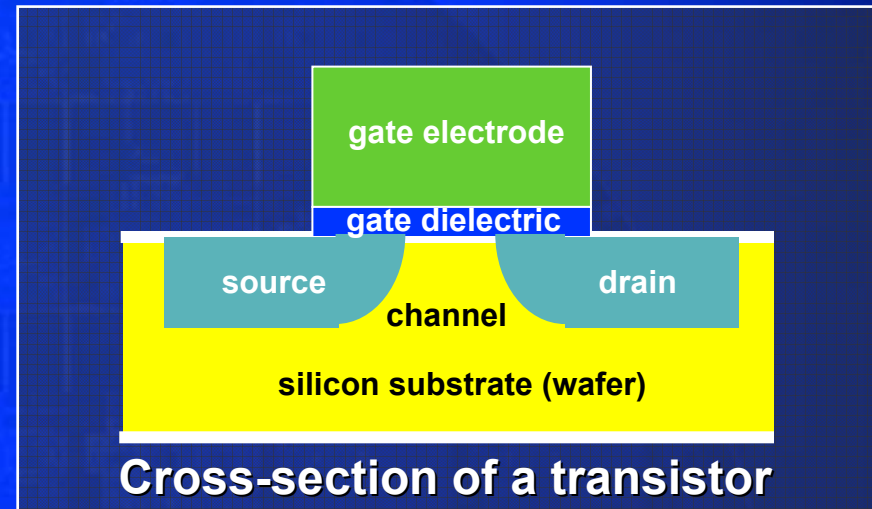
thirty-five years of innovation →

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What is a transistor?

- **A simple switch**

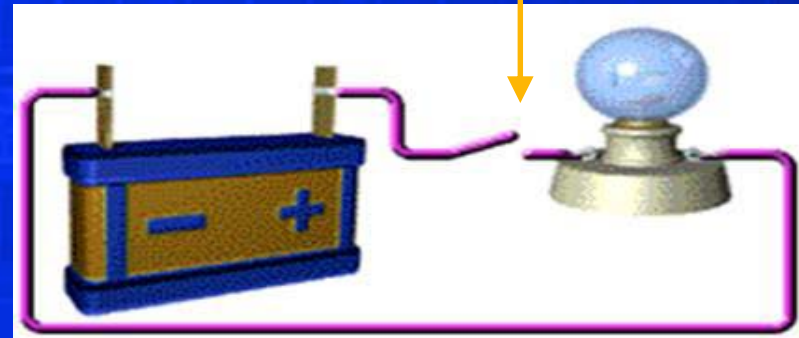
- Current flows from source to drain when gate is at certain voltage; otherwise, it doesn't flow (the gate's voltage is analogous to the position of a light switch)



- **Objective in transistor design: Make them smaller, faster, cheaper and less power-hungry**

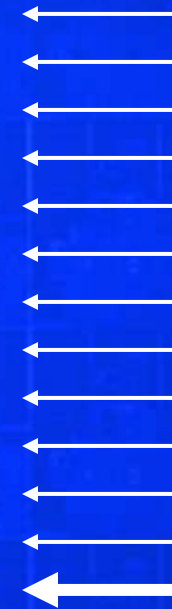
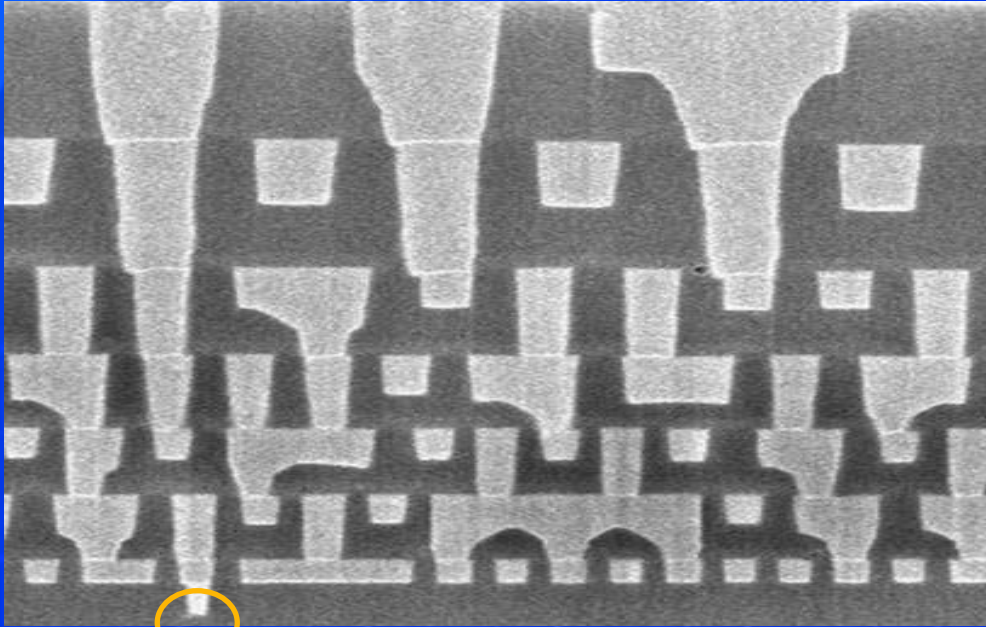


Flicking a
switch 1.5
trillion times per
sec



Fundamental component of all logic chips

Cross-section of a 90nm wafer

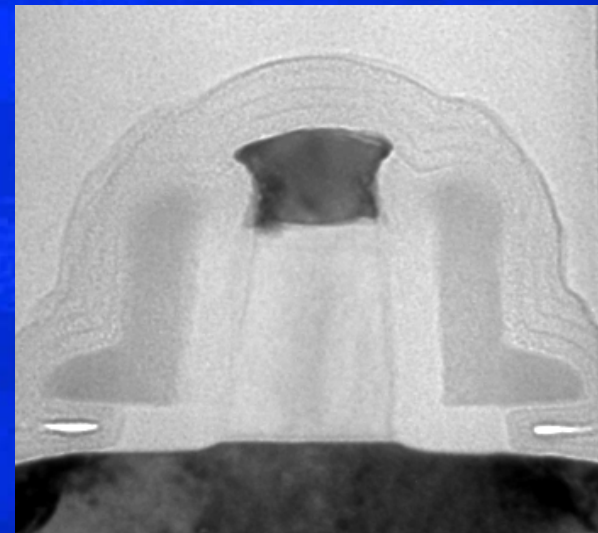


Multiple layers.

Silicon Substrate

A single transistor

$1/2000^{\text{th}}$ the width of a hair



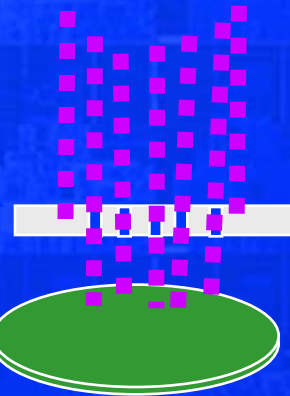
thirty-five years of innovation →

What happens in the semiconductor clean room

RETICLE
(Pattern with 0.7 micron
apertures ie 4 X 0.18



Lithography.



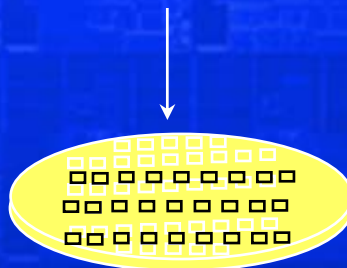
Silicon Wafer



**Light
Sensitive
Coating.**



Multiple Layers.
>350 process steps.



**CREATING > 125 million
TRANSISTORS ON EACH
MICROPROCESSOR;**

**WITH FEATURES 1/2000th THE
WIDTH OF A HUMAN HAIR.**

intel

thirty-five years **35** of innovation →

What is Nanotechnology?

Nanotechnology Definition

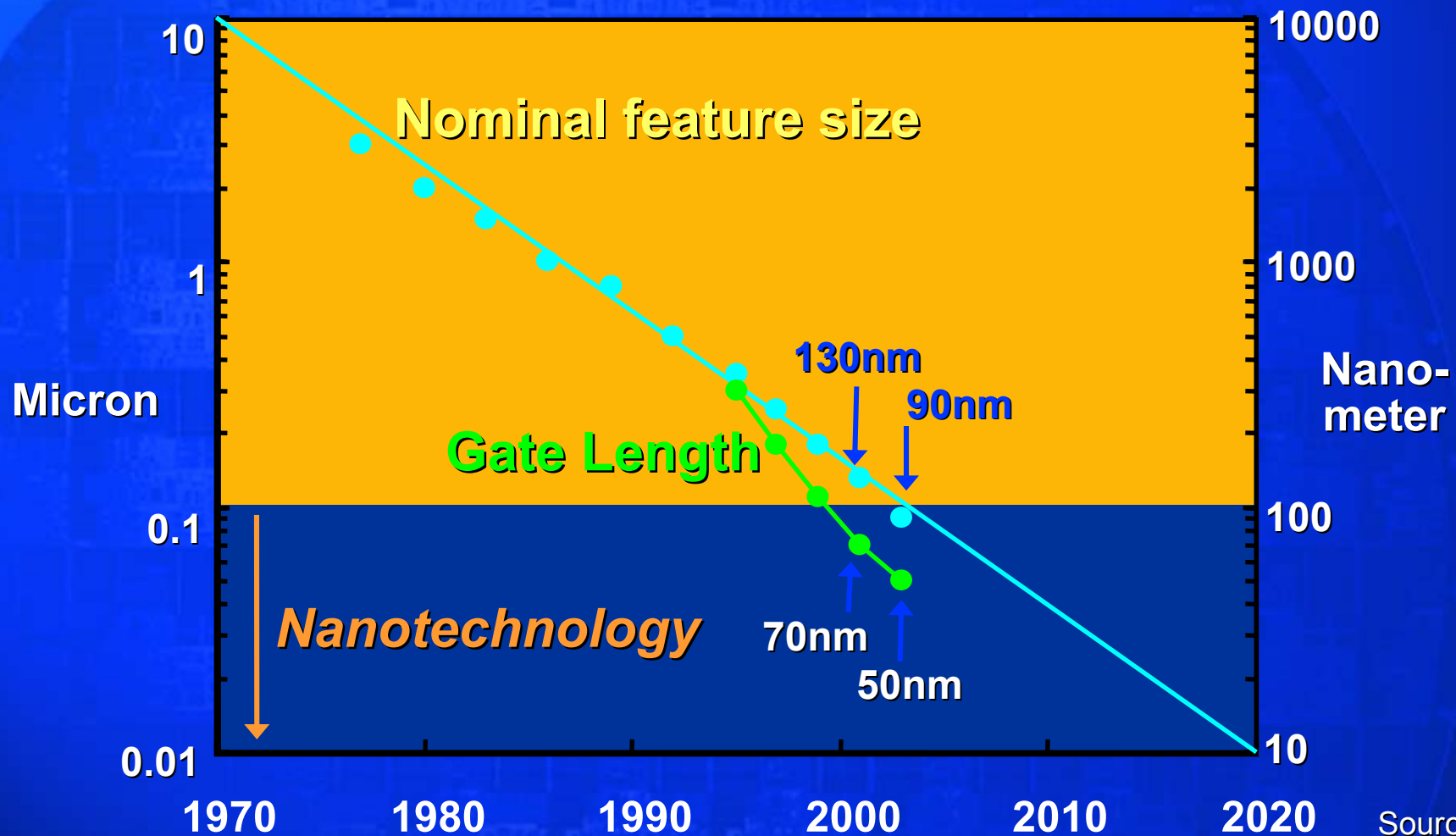
(Dr. Mike Roco, National Science and Technology Council, February 2000)

Research and technology development at the atomic, molecular or macromolecular levels, in the length scale of approximately

1 - 100 nanometer

range, to provide a fundamental understanding of phenomena and materials at the nanoscale and to create and use structures, devices and systems that have novel properties and functions because of their small and/or intermediate size.

Intel crossed 100 nm threshold in 2000

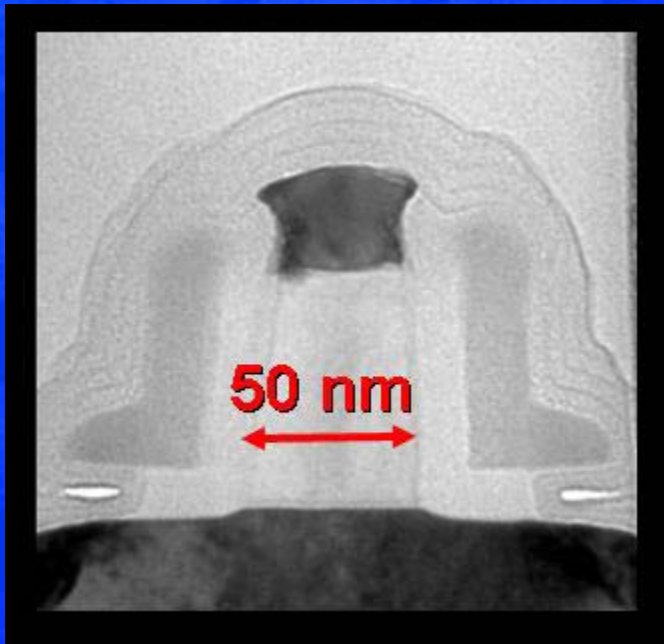


Generated > \$ 20 billion revenues in 2003

tion →

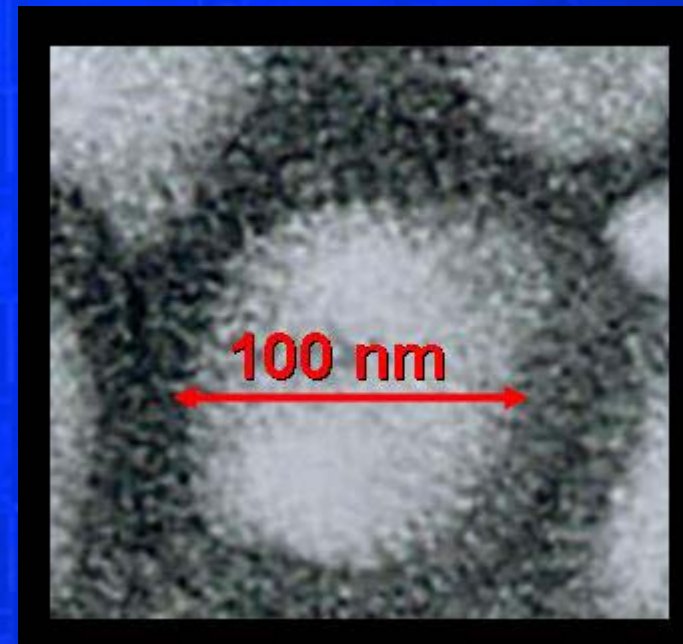
Intel Silicon Nanotech **Today**

50 nm transistor dimension is ~ 2000x smaller than diameter of human hair



**Transistor for
90nm-node**

Source: Intel



Influenza virus

Source: CDC



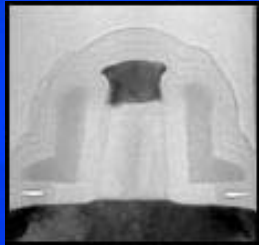
Gate dielectric thickness = 1.2 nm

thirty-five years of innovation →

35

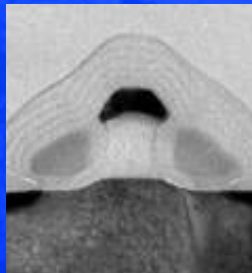
CMOS Device Scaling Demonstration

90nm Node
2003



50nm Length
(IEDM2002)

65nm Node
2005



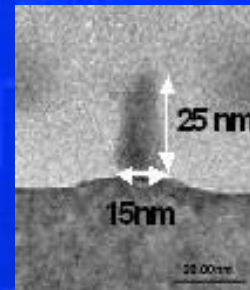
30nm
Prototype
(IEDM2000)

45nm Node
2007



20nm Prototype
(VLSI2001)

32nm Node
2009



15nm Prototype
(IEDM2001)

22nm Node
2011



10nm Prototype
(DRC 2003)

**Intel Research Devices scale to 10nm (22nm node)
Channel engineering solutions (Nanowires/Nanotubes)
will extend device scaling through end of next decade**



Source: Intel; Morales and
Lieber
Science, 279, 208, 1998

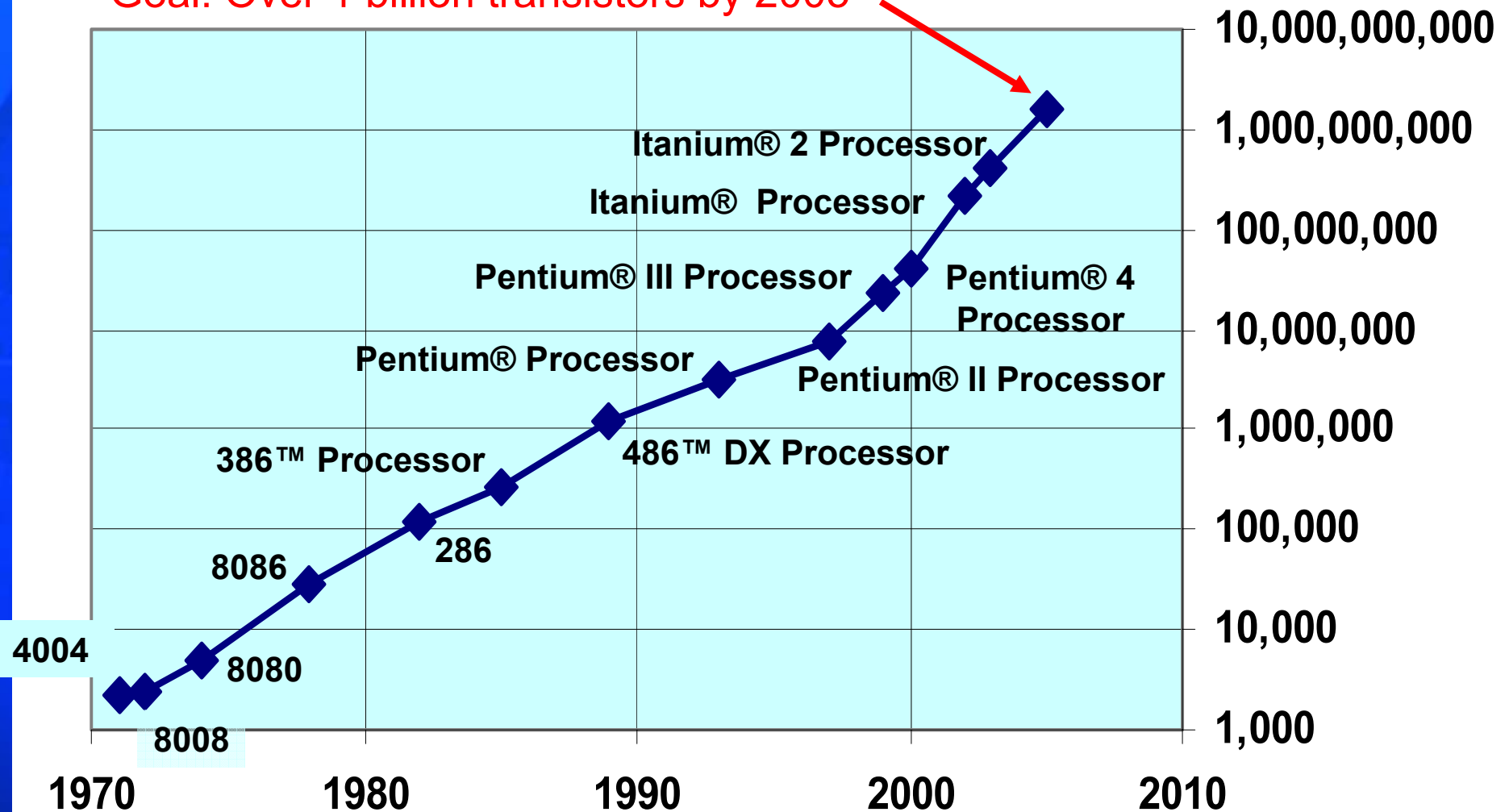


Density Is What Counts

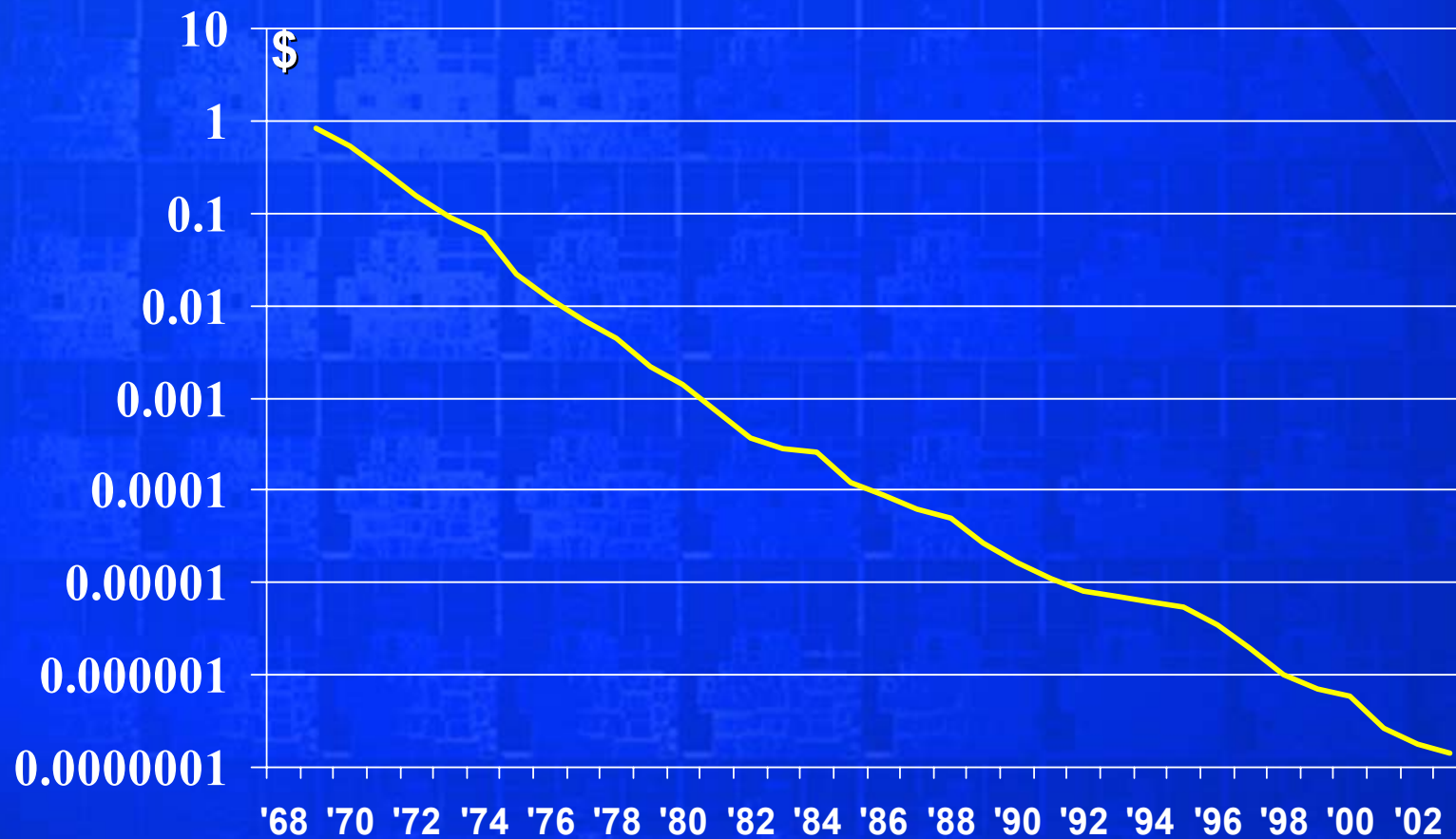


Moore's Law Continues

Goal: Over 1 billion transistors by 2005



Average Transistor Price by Year



Source: WSTS/Dataquest/Intel, 3/04

**For further information on Intel's silicon
technology, please visit the Silicon
Showcase at
www.intel.com/research/silicon**

